Slow Release Nitrogen Fertilizers, Nitrogen Stabilizers, and Poultry Manure

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Arkansas Plant Food Association Soil Fertility Training
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USDA Southern Water Quality Program
Agrium Advanced Technologies

Disclaimer

Mention of any trade name is for the purpose of facilitating the communication. It does not imply endorsement of such product, or exclusion of similar product(s) that may be equally effective, by the University of Arkansas Division of Agriculture.
Presentation Outline

- Slow release N fertilizers
- Nitrogen stabilizers
- Poultry litter
What happens to our N fertilizer

N from fertilizer

Plant uptake

Soil solution Ammonium $\text{NH}_4^+$

Nitrification

Soil solution Nitrate $\text{NO}_3^-$

Volatilization

Denitrification

Runoff and erosion

Leaching

Loss from soil

Adapted from IPNI

N from fertilizer
Slow Release N Fertilizers

- Sulfur coated urea
  - Elemental S encapsulated urea (~36-38% N)

- Polymer coated urea (~35% N)
  - Nutrient release rate controlled by
    - polymer chemistry
    - Thickness
    - Temperature and moisture

- Brand names: Osmocote, ProKote, Nutricote, ESN

Courtesy: Professor Rick Norman, U of A Division of Agriculture
Environmentally Smart Nitrogen (ESN)
Effect of urea and ESN on seedcotton yield
(Marianna, 2010)
Effect of urea and ESN on corn yield

(Marianna, 2010)
Presentation Outline

✓ Slow release N fertilizers

- Nitrogen stabilizers
- Poultry litter
Surface applied urea
Urea + NBPT

Slows Urea Conversion to NH$_3$ Gas

$2\text{NH}_3$  ammonia gas on soil surface
or in flood
- $\text{H}_2\text{O} \& \text{CO}_2$

CO(NH$_2$)$_2$  urea
$\xrightarrow{\text{urease}}$ (NH$_4$)$_2$CO$_3$  (pH ~ alkaline)
$\rightarrow 2\text{NH}_4^+ + 2\text{OH}^-$

Note: NBPT is a urease inhibitor which temporarily blocks urea conversion.
## Effects of N source and application time on rice yield (2003)

<table>
<thead>
<tr>
<th>N Fert Sources</th>
<th>N Rate (lb N/A)</th>
<th>Application time Prior to Flooding (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Urea</td>
<td></td>
<td>187</td>
</tr>
<tr>
<td>Agrotain</td>
<td>120</td>
<td>188</td>
</tr>
<tr>
<td>AS</td>
<td></td>
<td>181</td>
</tr>
<tr>
<td>LSD (0.05)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Norman et al., 2009; SSSAJ
Effect of urea and urea plus Agrotain on corn

![Bar chart showing corn grain yield (bu/acre) for different study sites with urea and urea plus Agrotain treatments.](chart.png)
Presentation Outline

✓ Slow release N fertilizers

✓ Nitrogen stabilizers

  ▪ Poultry litter
Some facts about N in poultry litter

- Almost all of the N is in organic form. Soil microbes breakdown (mineralize) organic N into ammonium and nitrate.

- Plant roots take up N from inorganic forms such as ammonia and nitrate.

- Organic N mineralization rate depends on:
  - soil physical and chemical properties (texture, pH, OM, …)
  - temperature
  - amount of rainfall
Effect of urea and fresh poultry litter on seed-cotton yield (Marianna, 2007)
Effect of N source and rate on corn yield
(Marianna, 2009)
Evaluating residual value of poultry litter

<table>
<thead>
<tr>
<th>N-source</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>None</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Urea</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Urea</td>
<td>100</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Urea</td>
<td>150</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Urea</td>
<td>200</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Urea</td>
<td>250</td>
<td>250</td>
<td>250</td>
</tr>
<tr>
<td>Urea</td>
<td>300</td>
<td>300</td>
<td>300</td>
</tr>
<tr>
<td>PPL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PPL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>PPL</td>
<td>0</td>
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<td>PPL</td>
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</tr>
<tr>
<td>PPL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

----- Total N rate (lb/acre) -----
Effect of urea and PPL on corn yield
(Marianna, 2005)

Corn grain yield (bu/acre)

Nitrogen rate (lb total N/acre)

PPL yield = 60% urea yield
Corn response to urea applied in spring 2006 and residual PPL applied in 2005

PPL yield = 15% urea yield
The Right Approach

Total amount of N plant needs

N from synthetic fertilizer (e.g. urea)

N from poultry manure
How to use poultry manure

Information needed

- Soil test results
- Manure test results
- Cost effectiveness
3. Recommendations

(Notice: State and/or federal nutrient management regulations may supersede these agronomic recommendations.)

<table>
<thead>
<tr>
<th>Crop</th>
<th>N</th>
<th>P₂O₅</th>
<th>K₂O</th>
<th>SO₄-S</th>
<th>Zn</th>
<th>B</th>
<th>Lime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Last Crop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop 1 Corn for Grain 200 bu/acre and up (4)</td>
<td>255</td>
<td>130</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5000</td>
</tr>
<tr>
<td>Crop 2 Cotton (6)</td>
<td>90</td>
<td>90</td>
<td>140</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5000</td>
</tr>
<tr>
<td>Crop 3 Soybean - Full Season (14)</td>
<td>0</td>
<td>80</td>
<td>160</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5000</td>
</tr>
</tbody>
</table>

4. Crop 1 Notes:
Apply one-third to one-half of the total N rate immediately before or after planting and side-dress the remainder when corn is 10-to 12-inches tall (V6 stage). Consider a 3-way split with a third split (45 lb N/acre) applied 1 to 2 weeks before tasseling.
If S-deficiency has occurred on this soil before apply 20 lb. SO₄-S/acre.
### Example of a Manure Analysis Report

**on "as-is" basis**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total %N</td>
<td>3.00</td>
</tr>
<tr>
<td>Total %P</td>
<td>1.31</td>
</tr>
<tr>
<td>Total %K</td>
<td>2.50</td>
</tr>
<tr>
<td>Total %Ca</td>
<td></td>
</tr>
<tr>
<td>Total %Carbon</td>
<td>28.54</td>
</tr>
<tr>
<td>NO3-N, mg/kg</td>
<td></td>
</tr>
<tr>
<td>NH4-N, mg/kg</td>
<td></td>
</tr>
</tbody>
</table>

**lbs/ton on "as-is" basis**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>60.0</td>
</tr>
<tr>
<td>P2O5</td>
<td>60.0</td>
</tr>
<tr>
<td>K2O</td>
<td>60.0</td>
</tr>
<tr>
<td>Ca</td>
<td></td>
</tr>
<tr>
<td>Total Carbon</td>
<td>570.8</td>
</tr>
<tr>
<td>NO3-N</td>
<td></td>
</tr>
<tr>
<td>NH4-N</td>
<td></td>
</tr>
</tbody>
</table>

***all analyses performed on "as-is" basis/ "dry" basis is calculated from moisture content

*lbs/ton P2O5 = %Total P on "as-is" basis multiplied by 20*2.29

*lbs/ton K2O = %Total K on "as-is" basis multiplied by 20*1.2
How much supplemental synthetic fertilizer do I need when I use manure?

<table>
<thead>
<tr>
<th>Nutrients balance sheet</th>
<th>N</th>
<th>P$_2$O$_5$</th>
<th>K$_2$O</th>
</tr>
</thead>
<tbody>
<tr>
<td>nutrients recommended by soil test</td>
<td>255</td>
<td>130</td>
<td>160</td>
</tr>
<tr>
<td>nutrients in one ton of poultry manure</td>
<td>60</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>nutrients supplied by one ton of manure*</td>
<td>36</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>supplemental nutrients needed from synthetic fertilizer</td>
<td>219</td>
<td>70</td>
<td>100</td>
</tr>
</tbody>
</table>

* assuming that 60% of N in the manure is available in the 1st year
# Poultry Litter Value as a Fertilizer Source

<table>
<thead>
<tr>
<th>Litter Analysis</th>
<th>Urea-N Price</th>
<th>Triple Super P</th>
<th>Potash</th>
<th>Sum Litter P, &amp; K Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>lb N-P$_2$O$_5$-K$_2$O/ton</td>
<td>$620/ton</td>
<td>$650/ton</td>
<td>$660/ton</td>
<td>$/ton</td>
</tr>
<tr>
<td>40-40-40</td>
<td>$26.80</td>
<td>$28.40</td>
<td>$22.00</td>
<td>$50.40</td>
</tr>
<tr>
<td>50-50-50</td>
<td>$33.50</td>
<td>$35.50</td>
<td>$27.50</td>
<td>$63.00</td>
</tr>
<tr>
<td>60-60-60</td>
<td>$40.20</td>
<td>$42.60</td>
<td>$33.00</td>
<td>$75.60</td>
</tr>
</tbody>
</table>

Retail Fertilizer Prices from Nov./Dec. 2012
$0.67 /lb urea-N
$0.71/lb P$_2$O$_5$
$0.55/lb K$_2$O

Courtesy: Professor N. A. Slaton, U of A Division of Agriculture
Take home message
Slow release N and N stabilizer

• When urea and ESN were preplant incorporated:
  ▪ Yield of cotton fertilized with ESN-N was higher than urea-N
  ▪ Grain yield of ESN-N fertilized corn was higher than urea-N fertilized corn
  ▪ ESN-N was a suitable alternative to urea-N for corn and cotton

• When potential for N loss by ammonia volatilization existed:
  ▪ Agrotain treated urea produced higher corn yields than non-treated urea
  ▪ Agrotain treated urea produced higher rice yields than non-treated urea
  ▪ NBPT is an effective urease inhibitor
Slow Release and N Stabilizers

• Ask your self ‘which N loss mechanism(s) are important to my situation’?

• Ask for data from replicated tests from multiple years & multiple locations

• Remember, you are (or your client is) farming to make money
Poultry Litter

- Supplement PL with synthetic fertilizer

- No difference between fresh and pelleted litter

- Residual value of N from poultry litter was small

- Cost effectiveness is the key
THANK YOU!

Questions?